



## ILLUMINATING NEW PATHS: EFFICACY OF PHOTOBIMODULATION IN THE TREATMENT OF SYMPTOMS IN CHILDREN WITH AUTISM SPECTRUM DISORDER – AN INTEGRATIVE REVIEW

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### REVISÃO INTEGRATIVA DA LITERATURA

#### ABSTRACT

Autism Spectrum Disorder (ASD), a neurodevelopmental disorder, is manifested by communication impairments and repetitive, stereotyped behaviors. There is no cure for ASD, but some of the symptoms can be treated. In this sense, research has explored the application of low-power red light, through transcranial photobiomodulation (tPBM) and laserpuncture, as a safe and effective alternative for alleviating symptoms in children diagnosed with ASD. This integrative review, revisiting recent literature on the use of laserpuncture and tPBM, sought to analyze the effectiveness of using these therapies to treat symptoms in children with ASD. The bibliographic search was carried out in the PubMed, SciELO and Science Direct databases, using the combined keywords: Autism, Photobiomodulation, Low laser therapy, Intravascular irradiation of blood, Laserpuncture, Low-level light therapy, Laser therapy. As a result, 104 articles were obtained, 5 of which were chosen to make up the review. The inclusion criteria adopted were studies in English from July 2004 to July 2024, which explored the treatment of symptoms in children diagnosed with ASD using low-power light. All the studies achieved positive results when using low-power light to treat the symptoms of children with ASD, and few side effects were reported. However, the small number of publications found and the size of the sample space, as well as the lack of standardization when it comes to the light-emitting device, time and exposure parameters are obstacles to a better understanding and degree of proof about the effectiveness of using this therapy in children with ASD.

**Keywords:** Autism Spectrum Disorder (ASD), Low-Level Light Therapy, Laser Therapy



# ILUMINANDO NOVOS CAMINHOS: EFICÁCIA DA FOTOBIO-MODULAÇÃO NO TRATAMENTO DE SINTOMAS EM CRIANÇAS COM TRANSTORNO DO ESPECTRO AUTISTA – UMA REVISÃO INTEGRATIVA

## RESUMO

Transtorno do Espectro Autista (TEA) é um distúrbio do neurodesenvolvimento caracterizado por prejuízos na comunicação e por comportamentos repetitivos e estereotipados. Embora não exista cura para o TEA, alguns de seus sintomas podem ser tratados. Nesse sentido, pesquisas têm explorado a aplicação de luz vermelha de baixa potência, por meio da fotobiomodulação transcraniana (tPBM) e da laserpuntura, como uma alternativa segura e eficaz para o alívio dos sintomas em crianças diagnosticadas com TEA. Esta revisão integrativa, ao revisitar a literatura recente sobre o uso da laserpuntura e da tPBM, buscou analisar a eficácia dessas terapias no tratamento dos sintomas em crianças com TEA. A busca bibliográfica foi realizada nas bases de dados PubMed, SciELO e ScienceDirect, utilizando as palavras-chave combinadas: *Autism, Photobiomodulation, Low laser therapy, Intravascular irradiation of blood, Laserpuncture, Low-level light therapy, Laser therapy*. Como resultado, foram obtidos 104 artigos, dos quais 5 foram selecionados para compor a revisão. Os critérios de inclusão adotados foram estudos em inglês, publicados entre julho de 2004 e julho de 2024, que explorassem o tratamento de sintomas em crianças diagnosticadas com TEA utilizando luz de baixa potência. Todos os estudos apresentaram resultados positivos com o uso de luz de baixa potência no tratamento dos sintomas de crianças com TEA, e poucos efeitos colaterais foram relatados. No entanto, o pequeno número de publicações encontradas e o tamanho reduzido das amostras, bem como a falta de padronização quanto ao tipo de dispositivo emissor de luz, tempo e parâmetros de exposição, representam obstáculos para uma compreensão mais profunda e maior evidência sobre a eficácia dessa terapia em crianças com TEA.

**Palavras-chave** Transtorno do Espectro Autista (TEA), Terapia com Luz de Baixa Intensidade, Laserterapia

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## **INTRODUCTION**

According to the Diagnostic and Statistical Manual of Mental Disorders (DSM V) [1], Autism Spectrum Disorder (ASD) is defined as a neurodevelopmental disorder characterized by persistent deficits in communication, social interaction, repetitive and stereotyped behaviors. In 2020, in the United States of America (USA), one in thirty-six children was identified with ASD, a prevalence that demonstrates a growing increase among children in recent decades [2]. This increase can be attributed to the broadening of diagnostic criteria, advances in diagnostic techniques and tools and the spread of knowledge among the population about the condition [3].

The manifestation of the disorder is heterogeneous among individuals on the spectrum, which makes its diagnosis difficult, since it is based on behavioral assessments [3]. The occurrence of symptoms attributed to other conditions concomitant with ASD is common [4], such as epilepsy and Attention Deficit Hyperactivity Disorder (ADHD) [5]. Other recurring characteristics in individuals with ASD are intellectual impairment, language impairment, motor deficits, anxiety, depression and catatonia-like behaviors [1]. All of this constitutes a condition that impairs the various spheres of the individual's life, with significant alterations such as sleep disturbances [6], emotional dysregulation, irritability and aggressiveness, as well as impairments in self-care and general quality of life, in addition to impacts on social interaction and the lives of family members [7].

The etiology of ASD is multifactorial and complex characterized by distinctive abnormalities of human cognitive functions, social interaction, and speech development. There is evidence of the hereditary nature of this disorder [8]. Therefore, genetic alterations are not the sole cause of the disorder. The way in which these genes are expressed is influenced by the environment in which the individual is inserted, making up their phenotype. There is a scientific consensus that associates the environmental factors present during the child's development with ASD [3]. The age of the parents (especially the father), the fetal environment (related to hormones and the mother's health), the use of medication (valproate, selective serotonin reuptake inhibitors), smoking and alcoholism, malnutrition and exposure to toxins (pollutants, pesticides) are all risk factors associated with ASD [9].

Like other neurodevelopmental disorders, there is no treatment for ASD, the interventions available are targeted at certain symptoms. In terms of pharmacological intervention, two antipsychotic drugs are approved by the FDA (Food and Drug Administration): risperidone and aripiprazole, both recommended for the management of irritability and emotional dysregulation in ASD. However, this has not been confirmed for children. In addition, these drugs can have various side effects such as weight gain and metabolic syndrome [10].

To minimize deficits and symptoms, non-pharmacological treatments are practiced, such as educational interventions including behavior analysis (ABA) with a high level of evidence, Early Social Interaction (ESI) and the Denver Early Start Model (ESDM) [5]. Complementary and alternative medicine is also present in the field of treating ASD symptoms in children, such as photobiomodulation, acupuncture and a combination of the two: laserpuncture [14, 15].

The use of low-power infrared or red light is called photobiomodulation (PBM). One of its approaches is transcranial photobiomodulation (tPBM). Following specific techniques and wavelengths, the light is delivered to certain chromophores to be absorbed by the brain tissue, promoting an increase in mitochondrial membrane potential and therefore greater ATP production by the mitochondria [16]. In addition, there is evidence of other mechanisms



triggered or potentiated by photobiomodulation that culminate in cytoprotective, antioxidant, antiapoptotic effects and increased cerebral blood flow [16]. The tPBM can also decrease neuroinflammation, increase neurogenesis and synaptogenesis [14].

Acupuncture is a legacy of Traditional Chinese Medicine, which has been used for treatment purposes for over two millennia. According to this theory, the body is passed through channels called meridians, through which vital energy (qi) is conveyed. Pathogenesis is explained by an imbalance in this energy. The practice of acupuncture is therefore a way of restoring the flow of qi by inserting fine needles into acupuncture points on the surface of the body. There are approximately 400 of these points interconnected through the 14 meridians [15].

Laserpuncture can be considered another form of photobiomodulation application, in which, instead of needles, low-intensity infrared light is used on the acupuncture points [15]. Thus, it promotes the effects referred to in acupuncture and has advantages over this traditional therapy, due to the sterility of the process and the shorter session time [17]. Like tPBM, laser acupuncture can promote an increase in cerebral blood flow, reducing pro-inflammatory substances such as tumor necrosis factor alpha (TNF- $\alpha$ ), interleukin-6 (IL-6), c-reactive protein (CRP), nitric oxide synthase (ONS) and also promoting anti-apoptotic and neuroprotective effects [18]. In the literature, there are no records of adverse effects or significant complications from the use of laser acupuncture. All this makes it a promising treatment that needs further investigation and analysis [17].

Although studies [8, 19, 20] have demonstrated the benefits of using photobiomodulation and laserpuncture in children with ASD, individual results, differing in relation to the age of the children, sample size, technique and frequency of application and form of evaluation, can lead to uncertainties regarding the effectiveness of these therapies. This review therefore set out to analyze studies over the last 20 years relating to the use of tPBM and laserpuncture in children with ASD.

## **METHODOLOGY**

Integrative review is a method that aims to summarize and present different perspectives to better understand a phenomenon and is an important tool for evidence-based health practice. In order for this category of review to be rigorous and accurate, it is necessary to follow specific methodological strategies covering its phases. The initial stage consists of formulating the purpose/problem [21]. Thus, the purpose of this study is to answer the question: What are the effects of using photobiomodulation therapy in children diagnosed with ASD?

This is followed by the other stages of the review with the aim of rigorously and critically answering the guiding question. These are: the bibliographical research phase, the data evaluation phase, data analysis, consisting of: data reduction, display and comparison, and finally, the conclusion and verification phase [21].

The bibliographic search was conducted in the electronic databases PubMed, SciELO, and ScienceDirect for articles published in English between July 2004 and July 2024. The descriptors used in the search were: “photobiomodulation,” “autism spectrum disorder,” “low laser therapy,” “intravascular irradiation of blood,” “laserpuncture,” and “low-level light therapy,” as shown in Charts 1 and 2.

The Boolean operator “AND,” was applied to combine the descriptors and refine the search strategy, to associate different concepts, ensuring that the articles contained all selected terms. The inclusion criteria were: (1) studies published within a 20-year period (July 2004 to July 2024);



(2) studies that addressed the treatment of symptoms in children diagnosed with ASD using low-power light; and (3) studies published in English. The exclusion criteria were: (1) studies without full-text availability; (2) studies that analyzed therapies other than low-power light; (3) articles focusing on diseases or disorders other than Autism Spectrum Disorder; (4) studies in which participants were over 18 years of age; and (5) studies conducted on animal models.

Chart 1:

#1	Autism
#2	Photobiomodulation
#3	Low level laser therapy
#4	Intravascular irradiation of blood
#5	Laserpuncture
#6	Low-level light therapy
#7	Laser therapy

Chart 2:

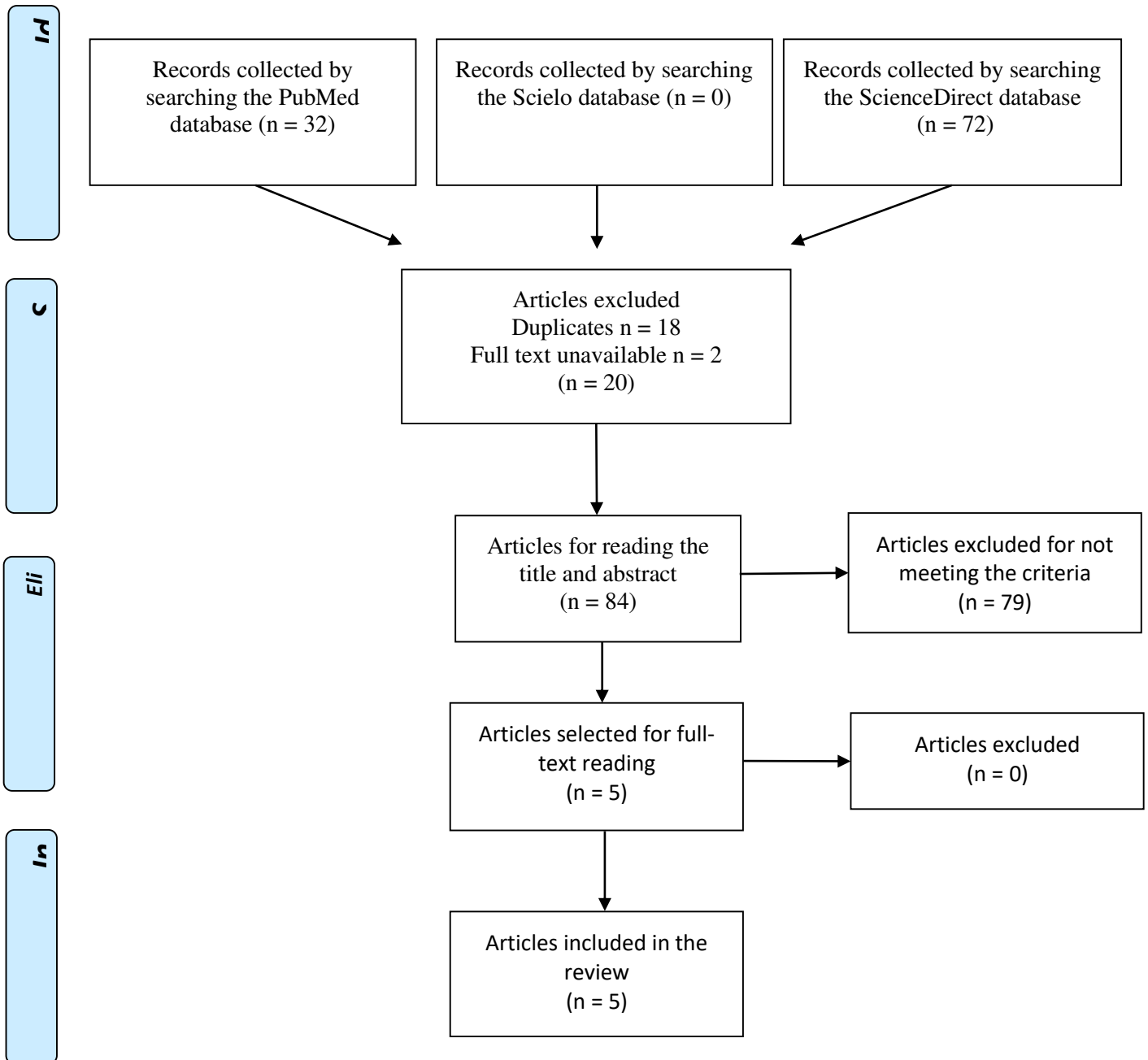
Database	Key words	Number of articles found
PubMed	#1 AND #2	11
	#1 AND #3	1
	#1 AND #4	0
	#1 AND #5	1
	#1 AND #6	2
	#1 AND #7	17
Science Direct	#1 AND #2	15
	#1 AND #3	0
	#1 AND #4	0
	#1 AND #5	0
	#1 AND #6	5
	#1 AND #7	52

## RESULTS

No matches were found in the SciELO database for the combinations of terms used. In total, 104 articles were identified. Of these, 18 duplicates were removed, along with 79 articles that did not meet the inclusion criteria based on title and abstract, and 2 that did not have full-text availability. As a result, 5 articles remained, as illustrated in Figure 1. All 5 are clinical trials that meet the proposed inclusion criteria. Chart 3 summarizes the data from the selected articles.



Figure 1.



Fonte: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

Three of the five articles analyzed the efficacy of low-level laser therapy using transcranial photobiomodulation, while the other two trials investigated the efficacy of low-level lasers and LEDs through laserpuncture therapy in children diagnosed with ASD. All five selected clinical



trials reported positive results. Each study concluded that the therapy used in their respective trial—either laserpuncture or transcranial photobiomodulation—was effective in treating the main manifestations of ASD and represents a safe and promising therapeutic approach.

Chart 3.

AUTHOR AND YEAR	TYPE OF STUDY AND AGE OF CHILDREN	OBJECTIVE	METHODOLOGY AND INTERVENTION	CONCLUSIONS
<p>(A) Imtiaz Amrinusantara Surap aty <i>et al.</i> (2020)<sup>18</sup></p>	<p>Clinical trial - 2 to 6 years</p>	<p>Determine the effects of laserpuncture on speech ability and social interactions in patients with ASD</p>	<p>46 participants were divided into a control group (1) and an experimental group (2). 2 received integrative sensory-occupational therapy and verum laserpuncture therapy 3 times a week for 6 weeks. The activation of the RJ-Laser Laserpen Praxis, type 130 was applied to each acupuncture point in group 2, in a Nogier G 18688-Hz frequency modulation wave, at 1 Joule dose/acupuncture point, at 40 m W of power and at 785 nm (infrared). Group 1 received integrative sensory-occupational therapy and placebo laserpuncture therapy. Speech ability and social interaction were</p>	<p>Verum laserpuncture was effective in improving comprehension, expression and social interaction in patients diagnosed with ASD, compared to placebo laserpuncture.</p>



			analyzed using the WeeFIM questionnaire and a sensory profile questionnaire was also administered to the participants' parents.	
(B) Mai S. Elsheikh et al. (2023) <sup>20</sup>	Clinical trial - 5 to 12 years	To investigate the influence of biostimulation with low-intensity laser acupuncture (LLLA) on severity, language skills, BDNF levels and miR-320 in a sample of children with ASD.	30 children diagnosed with ASD were divided into two groups: Group I, which received 12 sessions of biostimulation, two sessions a week of low-intensity laser acupuncture (LLLA) with a gallium-aluminum arsenide laser with a power of 200 mW and a wavelength of 850 nm, and Group II, which did not. The family was advised to stimulate the children's language development. The severity of autism was assessed using the Autism Rating Scale (CARS) and the Preschool Arabic Language Scale was applied to assess language skills, both before and after the intervention. Blood samples were also taken from participants with ASD before	Language stimulation associated with LLLA treatment proved effective in improving language skills and adjusting plasma levels of BDNF. The levels of this factor did not change with language stimulation by the parents. The article indicates that LLLA therapy is promising for managing the disorder and points to miR-320 levels as a possible biomarker for diagnosing ASD.



			and after treatment and from 15 neurotypical children to analyze BDNF levels and miR-320 expression.	
(C) Gerry Leisman <i>et al.</i> (2018) <sup>19</sup>	Clinical trial - 5 to 17 years	To examine the efficacy of low-level laser therapy, a form of photobiomodulation, for the treatment of irritability associated with autism spectrum disorder in children and adolescents aged 5 to 17.	40 individuals diagnosed with ASD were allocated into two groups: the test group received eight laser light applications of 5 minutes each at the base of the skull and in the temporal areas with Erchonia® Laser EAL, a 635 nm pulsed laser with a power of 15 mW for 4 weeks, and the placebo group received a 635 nm red LED. Assessments were carried out before treatment, during 2 weeks (midpoint) and 4 weeks (endpoint) of treatment and then: 8 weeks after treatment (post-procedure assessment): Aberrant Behavior Checklist (ABC) and Clinical Global Impressions Scale (CGI), including a disease severity scale (CGI-S) and a global improvement/change scale (CGI-C).	Low-power laser therapy is effective in reducing irritability, other behaviors and symptoms of ASD in children and adolescents, with changes that are maintained and increased over time.



<p>(D) Yuliy Fradkin <i>et al.</i> (2024)<sup>22</sup></p>	<p>Clinical trial - 2 to 6 years</p>	<p>To examine the impact of transcranial photobiomodulation (tPBM) on ASD symptoms in children aged two to six.</p>	<p>30 children diagnosed with ASD were divided into two groups, an active control and a Sham control, with 16 and 14 participants respectively. The active group received treatment with an experimental head-mounted device specifically designed to treat children with ASD, the Cognilum™. This device has 6 LEDs that emit pulsed light (40 Hz) at a wavelength of 850 nm, with a total maximum power of less than 300 mW. Two treatment sessions were carried out per week for 8 weeks. Before and after the treatment, the CARS was applied and the parents were asked questions. Electroencephalogram (EEG) data was collected at each session.</p>	<p>Positive results were reported in the parents' rating of the active group and also in the CARS assessment of this group. These and the other results led the authors to conclude that tPBM treatment can be safe and effective for treating children with ASD.</p>
<p>(E) Stefano Pallanti <i>et al.</i> (2022)<sup>23</sup></p>	<p>Clinical trial - 5 to 15 years</p>	<p>Test the efficacy of transcranial photobiomodulation using the alpha and gamma protocols</p>	<p>We analyzed the data of 21 ASD patients who received six months of tPBM, using the Vielight® Neuro Alpha/Gamma photobiomodulation</p>	<p>tPBM appears to be a promising intervention, given its results, practicality and freedom of movement.</p>



			<p>on brain stimulator, for 5 days a week, for 6 months at home, using two protocols (one alpha and one gamma) per day. The Alpha stimulator provides near-infrared light of 810 nm pulsing at 10 Hz. The gamma pulses light at a frequency of 40 Hz and provides near infrared light of 810 nm, both via transcranial LEDs placed in a helmet and an intranasal neurostimulator that has a wavelength of 810 nm near infrared light LED that provides NIR through the nasal canal and a power of 25 mW. Before and after three and six months of treatment, the Childhood Autism Rating Scale (CARS), Home Situation Questionnaire-ASD (HSQ-ASD), Autism Parenting Stress Index (APSI), Montefiore Einstein Rigidity Scale-Revised (MERS-R), Pittsburgh Sleep Quality Index (PSQI) and Scala per i Disturbi di</p>	<p>This indicates the need for more research in the area to confirm the results found.</p>
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			Attenzione/Iperattività per Genitori (SDAG) were carried out.	
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## DISCUSSION

This review analyzed the effects of transcranial photobiomodulation therapy (tPBM) and laserpuncture in children with ASD, as well as to discuss the potential limitations resulting from the scarcity of studies and the lack of methodological standardization in the available literature.

Of the five clinical trials selected, two analyzed the application of laserpuncture (A and B), while the other three evaluated the effects of tPBM (C, D, and E). Each study covered a specific age group of childhood and/or adolescence, ranging from 2 to 17 years old. Except for one study (E), the others included a test group and a control group. The sample size varied from 21 to 46 children across the studies.

Considering the effects of the therapy, studies involving murine models and adults with ASD support the hypothesis that photobiomodulation is an effective therapy for attenuating ASD symptoms. Kim et al. (2022) demonstrated that laser treatment in rats with an ASD model (induced by prenatal exposure to valproic acid) was effective in mitigating developmental abnormalities and improving both motor function and social interaction [24]. A pilot study that initially enrolled 11 adults aged 18 to 59 years concluded with 5 participants completing an 8-week tPBM protocol. The treatment was associated with a significant reduction in total scores on the Social Responsiveness Scale – Second Edition (SRS-2) at the final endpoint (SRS-2:  $-30.6 \pm 23$ ,  $p < 0.001$ ), with notable improvements in the subscales of Social Awareness ( $-3.0 \pm 1.9$ ,  $p < 0.001$ ), Social Communication ( $-10.3 \pm 6$ ,  $p < 0.001$ ), Social Motivation ( $-5.0 \pm 2.4$ ,  $p < 0.001$ ), and Restricted/Repetitive Behaviors ( $-7.4 \pm 4.1$ ,  $p < 0.001$ ). In addition, statistically significant improvements were observed in the final scores of the Global Assessment of Functioning ( $+12.8 \pm 4.2$ ,  $p < 0.001$ ) and the Life Satisfaction and Pleasure Questionnaire ( $+6.0 \pm 7.9$ ,  $p = 0.02$ ) [25].

These findings are consistent with the results of the articles analyzed in this review. All five studies reported positive outcomes following the application of photobiomodulation in children diagnosed with ASD (active group).

Surapaty et al. (A), using the WeeFIM questionnaire as the primary tool to assess speech and social interaction, along with a parental report, found significant differences between the placebo and active groups. Verum laserpuncture led to an 18.8-fold increase in the WeeFIM comprehension score. Furthermore, a greater number of participants in the verum group showed improvements in expression (16 vs. 1), social interaction (20 vs. 11), and parental report outcomes (10 vs. 9), compared to the placebo group.

Elsheikh et al. (B), using the Childhood Autism Rating Scale (CARS) comprising 15 items that assess domains such as verbal communication, emotional response, and interpersonal relationships — along with language assessments, concluded that laser acupuncture led to a reduction in CARS scores and a significant improvement in language abilities, including comprehension and verbal expression. Additionally, the study reported advancements in both verbal and non-verbal communication, greater adaptability to change, and improved social interaction.



Leisman et al. (C), using the Aberrant Behavior Checklist (ABC) which includes a global scale and five subscales (irritability/agitation, lethargy/social withdrawal, stereotyped behavior, hyperactivity/non-compliance, and inappropriate speech)—along with the Clinical Global Impressions Scale (CGI), administered at baseline, and at weeks two, four, and post-treatment, also reported favorable outcomes. Most participants who received the active treatment showed improvement in ASD symptoms, with 13 out of 20 classified as “much improved”. The ABC scores of the test group decreased progressively throughout the study, with effects sustained even four weeks after the last LLLT session. In contrast, no improvement was observed in the placebo group in either assessment.

Fradkin et al. (D), using CARS assessments, electroencephalogram (EEG) recordings during each session, and weekly interviews, found that 87% of participants in the active group achieved a minimum clinically important reduction in CARS scores, a significantly higher proportion compared to the 35% observed in the sham group. Additionally, a positive correlation was identified between the reduction in CARS scores and the decrease in delta wave activity, as well as a negative correlation between the reduction in CARS scores and the increase in theta wave power, suggesting a relationship between behavioral symptoms and brain wave distribution.

Finally, Pallanti et al. (E) carried out assessments covering CARS, measures of parental stress, attention, cognitive stress, sleep quality and non-compliant behavior. The main findings indicated a reduction in ASD severity, accompanied by improvements in cognitive and behavioral impairment (MERS-R), sleep quality (PSQI) and attention (SDAG). In addition, a decrease in non-compliant behavior (HSQ-ASD) was observed.

As noted, specific analyses were conducted by individual articles, demonstrating potential associations between changes in brain wave distribution (D), plasma BDNF levels, and miR-320 expression (B) with ASD and PBM. These findings suggest possible correlations between the use of PBM and the regulation of BDNF levels and brain wave patterns, as well as indicating miR-320 expression as a potential diagnostic biomarker for ASD.

The positive outcomes presented, as noted by Hamblin (2022) [14], demonstrate that the use of photobiomodulation therapy is a promising approach in the treatment of children diagnosed with ASD. In conclusion, Hamblin emphasized that the neural and synaptic stimulating effects of PBM, when combined with psychotherapeutic and educational interventions, hold great potential. In studies that evaluated both PBM and language stimulation methods (e.g., study B), the active group receiving both interventions achieved greater improvements than the group exposed solely to the stimulating environment.

PBM is not only effective but also safe. Minor side effects were reported in two (D and E) of the five studies included, such as increased irritability (D) and occasional headaches (E). Furthermore, as a non-invasive treatment with sterile application procedures, PBM promises [1] for broader adoption in the management of neurodevelopmental disorders, including ASD-related symptoms.

The selected articles address two approaches to the use of low-intensity infrared light: transcranial therapy and laser acupuncture. Some studies used laser devices (A and B), while others employed LEDs (C, D, and E). The main difference between lasers and LEDs lies in the way light is emitted. Lasers emit coherent light, whereas LEDs emit non-coherent light. However, when emission parameters are equivalent, their effects are similar [26]. In addition to the different light application devices, as shown in Chart 3, parameters such as intensity, application time, and number of sessions vary across studies. The effects of laser therapy are significantly influenced by these characteristics [26]. This variability presents a barrier to analyzing and



comparing the studies and represents a limitation of this review. Therefore, it is essential to conduct research following a standardized methodology to elucidate the molecular mechanisms of light action, strengthen the evidence base regarding its efficacy, and identify other potential applications and benefits of PBM.

This review is limited by the small number of included studies, their reduced sample sizes, and methodological heterogeneity regarding treatment parameters and evaluation methods. Most trials had short follow-up periods and insufficient information about randomization or blinding, which may introduce bias. Additionally, few studies explored the biological mechanisms of photobiomodulation or discussed ethical aspects. Further standardized and well-controlled clinical trials studies are necessary to better understand the biomolecular mechanisms involved and to support the broader adoption of this therapeutic approach.

## CONCLUSION

It can be concluded that the use of low-intensity light, whether through laser acupuncture or transcranial photobiomodulation therapy (tPBM), can produce positive effects in children diagnosed with autism spectrum disorder (ASD). The studies analyzed reported reductions in the severity of ASD symptoms, as well as improvements in language, communication, and social interaction. However, the evidence is limited, based on heterogeneous studies with small sample sizes. Further clinical studies are suggested so that these results can be strengthened.

## REFERENCES

- <sup>1</sup> ASSOCIATION, A. P. **Diagnostic and Statistical Manual of Mental Disorders Fifth Edition**. Arlington, VA 2013.
- <sup>2</sup> MAENNER, M. J. et al. Prevalence and Characteristics of Autism Spectrum Disorder Among Children Aged 8 Years - Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2020. **MMWR Surveill Summ**, v. 72, n. 2, p. 1-14, Mar 24 2023. ISSN 1545-8636. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/36952288> >.
- <sup>3</sup> KERESZTURI, É. Diversity and Classification of Genetic Variations in Autism Spectrum Disorder. **Int J Mol Sci**, v. 24, n. 23, Nov 26 2023. ISSN 1422-0067. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/38069091> >.
- <sup>4</sup> WANG, L. et al. Autism Spectrum Disorder: Neurodevelopmental Risk Factors, Biological Mechanism, and Precision Therapy. **Int J Mol Sci**, v. 24, n. 3, Jan 17 2023. ISSN 1422-0067. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/36768153> >.
- <sup>5</sup> CATHERINE LORD, M. E., GILLIAN BAIRD E JEREMY VEENSTRA-VANDERWEELE. **Autism spectrum disorder**. *Lancet. London, England*. 392: 508-520 p. 2018.
- <sup>6</sup> CORTESE, S. et al. Sleep Disorders in Children and Adolescents with Autism Spectrum Disorder: Diagnosis, Epidemiology, and Management. **CNS Drugs**, v. 34, n. 4, p. 415-423, Apr 2020. ISSN 1179-1934. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/32112261> >.
- <sup>7</sup> VASILOPOULOU, E.; NISBET, J. The quality of life of parents of children with autism spectrum disorder: A systematic review. **Research in Autism Spectrum Disorders**, v. 23, p. 36-49, 2016/03/01/ 2016. ISSN 1750-9467. Disponível em: < <https://www.sciencedirect.com/science/article/pii/S1750946715300064> >.
- <sup>8</sup> AL-DEWIK, N.; ALSHARSHANI, M. New Horizons for Molecular Genetics Diagnostic and Research in Autism Spectrum Disorder. **Adv Neurobiol**, v. 24, p. 43-81, 2020. ISSN 2190-



5215. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/32006356> >.
- <sup>9</sup> SVEN BOLTE, S. G. E. P. B. M. **The contribution of environmental exposure to the etiology of autism spectrum disorder.** *Cellular and Molecular Life Sciences*. 76: 1275–1297 p. 2018.
- <sup>10</sup> SIAFIS, S. et al. Pharmacological and dietary-supplement treatments for autism spectrum disorder: a systematic review and network meta-analysis. **Mol Autism**, v. 13, n. 1, p. 10, Mar 04 2022. ISSN 2040-2392. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/35246237> >.
- <sup>11</sup> MYERS, S. M.; JOHNSON, C. P.; DISABILITIES, A. A. O. P. C. O. C. W. Management of children with autism spectrum disorders. **Pediatrics**, v. 120, n. 5, p. 1162-82, Nov 2007. ISSN 1098-4275. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/17967921> >.
- <sup>12</sup> VANIA REIS GIRIANELLI, J. T., COSME MARCELO FURTADO PASSOS DA SILVA, CONCEIÇÃO SANTOS FERNANDES. **Diagnóstico precoce do autismo e outros transtornos do desenvolvimento, Brasil, 2013–2019** *Revista de Saúde Pública* 57: 2 p. 2023.
- <sup>13</sup> LEVY, S. E.; HYMAN, S. L. Complementary and alternative medicine treatments for children with autism spectrum disorders. **Child Adolesc Psychiatr Clin N Am**, v. 17, n. 4, p. 803-20, ix, Oct 2008. ISSN 1056-4993. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/18775371> >.
- <sup>14</sup> HAMLIN, M. R. Could Photobiomodulation Treat Autism Spectrum Disorder? **Photobiomodul Photomed Laser Surg**, v. 40, n. 6, p. 367-369, Jun 2022. ISSN 2578-5478. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/35613405> >.
- <sup>15</sup> YANG, C. et al. Efficacy and safety of acupuncture in children: an overview of systematic reviews. **Pediatr Res**, v. 78, n. 2, p. 112-9, Aug 2015. ISSN 1530-0447. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/25950453> >.
- <sup>16</sup> HAMLIN, M. R. Shining light on the head: Photobiomodulation for brain disorders. **BBA Clin**, v. 6, p. 113-124, Dec 2016. ISSN 2214-6474. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/27752476> >.
- <sup>17</sup> WEN LONG HU, C.-E. K., SZU-YING WU, YI-HSUN TSAI, HAN-CHING WANG, YU-CHIANG HUNG, CHIA HUI LIN E MAO-FENG SUN. Practical Applications of Laser Acupuncture. In: (Ed.). **Advanced Concepts in Medicine and Medical Research**, v.2, 2023. p.37-75.
- <sup>18</sup> SURAPATY, I. A. et al. Laser Acupuncture Effects on Speech and Social Interaction in Patients with Autism Spectrum Disorder. **Med Acupunct**, v. 32, n. 5, p. 300-309, Oct 01 2020. ISSN 1933-6586. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/33101575> >.
- <sup>19</sup> LEISMAN, G. et al. Effects of Low-Level Laser Therapy in Autism Spectrum Disorder. **Adv Exp Med Biol**, v. 1116, p. 111-130, 2018. ISSN 0065-2598. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/29956199> >.
- <sup>20</sup> ELSHEIKH, M. S. et al. Efficacy of Laser Acupuncture for Children With Autism Spectrum Disorder: Clinical, Molecular, and Biochemical Study. **Pediatr Neurol**, v. 147, p. 44-51, Oct 2023. ISSN 1873-5150. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/37552913> >.
- <sup>21</sup> ROBIN WHITTEMORE, K. K. **The integrative review: updated methodology.** *METHODOLOGICAL ISSUES IN NURSING RESEARCH*. 52: 546-553 p. 2005.
- <sup>22</sup> FRADKIN, Y. et al. Transcranial photobiomodulation in children aged 2-6 years: a randomized sham-controlled clinical trial assessing safety, efficacy, and impact on autism spectrum disorder symptoms and brain electrophysiology. **Front Neurol**, v. 15, p. 1221193, 2024. ISSN 1664-2295. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/38737349> >.
- <sup>23</sup> PALLANTI, S. et al. Transcranial Photobiomodulation for the Treatment of Children with Autism Spectrum Disorder (ASD): A Retrospective Study. **Children (Basel)**, v. 9, n. 5, May 20 2022. ISSN 2227-9067. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/35626932> >.
- <sup>24</sup> KIM, U. J.; HONG, N.; AHN, J. C. Photobiomodulation Attenuated Cognitive Dysfunction and



- Neuroinflammation in a Prenatal Valproic Acid-Induced Autism Spectrum Disorder Mouse Model. **Int J Mol Sci**, v. 23, n. 24, Dec 17 2022. ISSN 1422-0067. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/36555737> >.
- <sup>25</sup> CERANOGLU, T. A. et al. Transcranial Photobiomodulation in Adults with High-Functioning Autism Spectrum Disorder: Positive Findings from a Proof-of-Concept Study. **Photobiomodul Photomed Laser Surg**, v. 40, n. 1, p. 4-12, Jan 2022. ISSN 2578-5478. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/34941429> >.
- <sup>26</sup> ZEIN, R.; SELTING, W.; HAMBLIN, M. R. Review of light parameters and photobiomodulation efficacy: dive into complexity. **J Biomed Opt**, v. 23, n. 12, p. 1-17, Dec 2018. ISSN 1560-2281. Disponível em: < <https://www.ncbi.nlm.nih.gov/pubmed/30550048> >.